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Smart controls save fuel

By Gray Creech

Dryden Public Affairs

Dryden's versatile F/A-18 Full Scale Advanced Systems Testbed, or FAST, aircraft recently completed a series of flights that explored reducing fuel consumption during cruise flight conditions by making small modifications to existing control laws and mechanisms in the aircraft's flight control computer.

As part of the Intelligent Control for Performance, or ICP, research project, a special computer code called a peak-seeking algorithm was programmed into the aircraft's Airborne Research Test System computer. This code enables the computer to precisely adjust flight control surface deflections in order



ED10-0073-23

NASA/Lori Losey

Dryden's F/A-18A Full Scale Advanced Systems Testbed aircraft recently completed flying the Intelligent Control for Performance research project.

to reduce aerodynamic drag.

Large jetliners and cargo aircraft consume most of their fuel during the cruise portion of flight, so optimizing fuel consumption would reduce costs and pollution. For NASA, developing new control system methods like this helps meet the agency's Environmentally Responsible Aviation project goals of reduced fuel burn and emissions.

Preliminary ICP flight results indicate that a three- to five-percent reduction in fuel burn was achieved compared to the baseline trim state at two flight conditions. The ICP technique shows much promise for reducing fuel burn in transport

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SBLT-II project flights set to take off in 2013

By Gray Creech

Dryden Public Affairs

Dryden, in partnership with Aerion Corp., is preparing to fly another series of Supersonic Boundary Layer Transition, or SBLT-II, project flights on its F-15B Research Testbed aircraft in early 2013. Engineers are continuing an on-going investigation of the extent and robustness of natural laminar flow at supersonic speeds.

The experiment consists of flying a small test airfoil, or wing section, attached underneath the F-15B. Conducting the experiment in a real-world environment will enable engineers to capture data that will then be used to refine the airfoil design. The objective is to better understand when air transitions from laminar, or smooth, flow to rough, turbulent flow over a wing surface. The airfoil design, once validated and refined, could be adapted to the wing of Aerion's proposed supersonic business jet.

Laminar airflow results in less aerodynamic drag, which improves overall efficiency and reduces fuel consumption, several of the goals of NASA's Environmentally Responsible Aviation project.



ED96-43546-01

NASA/Jim Ross

Dryden photographer Jim Ross captured the F-15B aeronautical research testbed as it flew over Lake Isabella in Southern California's Kern County.

Hurricane study tools validated

By Robert Gutro

Goddard Space Flight Center

NASA's 2012 Hurricane and Severe Storms Sentinel, or HS3, mission concluded Nov. 5 when an unmanned NASA Global Hawk aircraft flew from Dryden on a final data-collection mission in the North Pacific Ocean over a large storm in preparation for next year's hurricane campaign.

The Global Hawk mission included a route along the Pacific Coast to as far north as Washington. The aircraft flew over four Pacific Ocean buoys and a low pressure system south of the Aleutian Islands in Alaska. The 24.2-hour flight allowed for testing of several instruments that will be flown during the 2013 HS3 campaign. All three instruments operated well and collected good data.

The mission capped a busy HS3 mission schedule that had begun in September. The 2012 HS3 missions included use of a second NASA Global Hawk aircraft to investigate the environment and cloud structure of hurricanes Leslie and Nadine in the Atlantic Ocean with more than 148 hours flown over six science flights. The second Global Hawk, which also is housed at Dryden, was temporarily located at NASA's Wallops Flight Facility in Wallops Island, Va. during the month-long mission.

Testing the HIWRAP Instrument

One of the instruments on this HS3 journey was the High-altitude Imaging Wind and Rain Airborne Profiler, or HIWRAP. This system maps 3-D winds and precipitation within hurricanes and other severe weather events. Gerry Heymsfield is the principal investigator for the HIWRAP and is a research meteorologist at NASA's Goddard Space Flight Center in Greenbelt, Md.

"HIWRAP measured



ED12-0332-02

NASA/Jim Ross

This Dryden-based Global Hawk, an unmanned aircraft system, was one of two Global Hawks used during NASA's HS3 hurricane study over the Atlantic Ocean.

precipitation and Doppler winds in the weather front associated with the low pressure system," Heymsfield said. "The vertical structure of this front is very interesting in preliminary looks since it was in a data-sparse region of the Pacific. We are really excited about looking at this data in more detail. While this data was not from a tropical weather system that we are interested in for HS3, the flight nevertheless allowed us to test upgrades to HIWRAP such as real time plots that are very promising for future flights."

Testing the HIRAD Instrument

A second instrument that flew on this final 2012 HS3 flight was the Hurricane Imaging Radiometer, or HIRAD. HIRAD is an instrument that measures surface wind speeds and rain rates using its rectangular antenna to track storm-induced fluctuations on the ocean's surface. The antenna measures microwaves emitted by the ocean surface that are increased by the storm. As winds move across the surface of the sea they generate white, frothy

foam. This sea foam causes the ocean surface to emit increasingly large amounts of microwave radiation. HIRAD measures that microwave energy and, in doing so, allows scientists to deduce how powerfully the wind is blowing.

With HIRAD's unique capabilities, the two-dimensional structure of the surface wind field can be much more accurately determined than current operational capabilities allow.

"The Pacific flight was a major step in the development and validation of the algorithms that retrieve wind and rain measurements from the microwave brightness temperatures," said HIRAD Principal Investigator Tim Miller of NASA's Marshall Space Flight Center in Huntsville, Ala.

HAMSRS validated

The High Altitude MMIC (Monolithic Microwave Integrated Circuits) Sounding Radiometer (HAMSRS) instrument was also tested during this flight over the Pacific Ocean. For HS3, HAMSRS will provide measurements of the moist thermodynamic state

(e.g. temperature, water vapor) and precipitation structure in and around a tropical cyclone, which are important measurements for understanding the storm dynamics and evolution.

During the Pacific Global Hawk flight, the HAMSRS quick-look temperature and water vapor profiles showed a transition from warmer, moister air to cold, dry polar air as the plane traversed a front associated with a low pressure system centered in the Gulf of Alaska.

"Because HAMSRS operates at microwave frequencies, it readily penetrates the clouds that are prevalent in the core regions of hurricanes, which allows us to map out the temperature, water vapor, cloud and precipitation structure there," said Bjorn Lambriksen, HAMSRS principal investigator at NASA's Jet Propulsion Laboratory, Pasadena, Calif. He noted that infrared sounders are "blinded" by those clouds, and dropsondes only give sparse spot samples. Neither infrared sounders nor dropsondes measure precipitation or cloud structure.

HAMSRS and the other two instruments previously flew in NASA's 2010 Genesis and Rapid Intensification Processes (GRIP) hurricane mission. During GRIP, the HIRAD flew aboard a WB-57 aircraft and HIWRAP and HAMSRS were mounted in a NASA Global Hawk.

The HS3 mission is an Earth Venture mission funded by NASA's Science Mission Directorate in Washington, D.C. Earth Venture missions are managed by NASA's Earth System Science Pathfinder Program at the agency's Langley Research Center in Hampton, Va. The Earth Science Project Office at NASA's Ames Research Center in Moffett Field, Calif., managed the HS3 mission. Scott Braun, the principal investigator or lead scientist, is from Goddard.



Open House

Dryden Center Director David McBride hosted an open house at Dryden's main campus on Dec. 12 and at the Dryden Aircraft Operations Facility in Palmdale the following day. Aside from highlighting some of the center's accomplishments in 2012, the Dryden Hallway Choir also performed at both events.

ED12-0384-03
NASA/Tom Tschida

Santa meets fans

Santa Claus took time off from his busy schedule to meet some of Dryden employees' children who attended the Children's Holiday Party at Mulligan's Family Fun Center in Palmdale. High-fiving Santa is Gustavo Carreño V, who is held by his mom, Leah Carreño. The Dryden Exchange Council sponsored the annual event.

ED12-0385-15
NASA/Tom Tschida



Dance the night away

Attendees of the Dryden Holiday Party Dec. 8 had an opportunity to celebrate the holidays with the Dryden family. The event was held at the Cascades Restaurant in Palmdale and included friends, family, food and fun.

ED12-383-66
NASA/Tom Tschida



News at NASA

Abdalati departs

Waleed Abdalati, who served as the first NASA chief scientist since 2005, will be leaving the agency at the end of 2012 to return to the faculty of the University of Colorado in Boulder.

Abdalati served as the principal science advisor to Administrator Charlie Bolden and other agency leadership on NASA-related science matters. In this role he has also been an advocate on matters of agency science policy, programs and achievements.

"NASA science continues to awe the world, and Waleed's contributions toward this vital national priority these past years have been essential," Bolden said.

During his tenure, Abdalati established an agency-wide Science Council, a science innovation program, and NASA's Framework on Scientific Integrity. These efforts were designed to integrate and promote innovation across NASA's entire science enterprise, and elevate the visibility of the agency's science capabilities both internally and externally. Over the past two years, he represented the agency's science interests at the White House and before Congress, and has spoken to over 100 audiences around the world.

Gale Allen, associate chief scientist for Life and Microgravity Sciences, will serve as acting NASA chief scientist until a successor is named. Allen joined the Office of the Chief Scientist in 2011 from the Exploration Systems Mission Directorate at Headquarters, where she was director of Strategic Integration and Management.

The year that was – 2012 key events

By Gray Creech

Dryden Public Affairs

Dryden helped advance the agency's overall mission of Earth and space science and aerospace technology research as it continued supporting NASA's key mission areas during 2012.

Aeronautics

X-48 Blended/Hybrid Wing Body

The remotely piloted "C" version of the X-48 Blended Wing Body sub-scale research aircraft successfully flew for the first time on Aug. 7. The new X-48C model was modified from its earlier X-48B configuration to evaluate the low-speed stability and control of a low-noise version of a proposed future Hybrid Wing Body aircraft design.

The project's 100th flight milestone occurred Oct. 30 when the X-48C made its seventh and eighth flights. Between 2007 and 2010, the aircraft, then in the X-48B configuration, made 92 flights. Designed by the Boeing Co. and built by Cranfield Aerospace Ltd. of the United Kingdom, the X-48 is flying in partnership with NASA.

Sonic Boom Research

In November, Dryden flew a series of low-supersonic, high-altitude flight profiles during the Farfield Investigation of No Boom Threshold, or FaINT, flight research project. The effort, involving several NASA centers, industry and university partners, collected data to expand the collective knowledge of sonic boom propagation effects to provide the data necessary for engineers to design future low-boom supersonic aircraft. The overarching goal of NASA's sonic boom reduction research is to



ED12-0255-54

NASA/Carla Thomas

The X-48C Blended Wing Body technology demonstrator lifts into the skies after taking off from Rogers Dry Lake at Edwards on its first test flight on Aug. 7, 2012.

shrink the sonic boom "footprint" in order to make civil supersonic flight over land practical.

Automatic Ground Collision Avoidance System

Dryden researchers successfully conducted flights tests of a miniature automatic ground collision avoidance system for small, unmanned aircraft last May. During final test flights of the software integrated into an autopilot on the Dryden Remotely Operated Integrated Drone research aircraft, the smartphone-assisted system consistently commanded evasive maneuvers when it sensed the aircraft was getting too close to rocky,



ED12-0306-10

NASA/Jim Ross

F/A-18B No. 852 flies near the Tehachapi Mountains. The aircraft flew a series of low-supersonic, high-altitude flight profiles during the Farfield Investigation of No Boom Threshold, or FaINT, flight research project.

mountainous terrain or ridgelines and impact with the terrain was imminent.

UAS in the NAS

On March 15, Dryden completed the first flights in the Unmanned Air Systems in the National Airspace project, using the unmanned MQ-9 Ikhana aircraft for evaluation of the Automatic Dependent Surveillance-Broadcast aircraft tracking system adapted for UAS. All aircraft operating in certain U.S. airspace must adopt ADS-B aircraft tracking technology by January 2020 in order to comply with Federal Aviation Administration regulations. The flight was the first time an unmanned aircraft as large as the MQ-9 had flown equipped with ADS-B. The initial flights checked out the system's capabilities in the "out" or transmit mode, while more recent flights evaluated the system's "in" or receive data mode and its ability to downlink information to the ground control station.

Earth and Space Science

HS3 Mission

The 2012 Hurricane and Severe Storm Sentinel, or HS3, mission in September saw a NASA Global Hawk aircraft fly from the agency's Wallops Flight Facility in Wallops Island, Va., to investigate the environment and cloud structure of hurricanes Leslie and Nadine in the Atlantic Ocean. This was the first deployment from Wallops for the Dryden-based aircraft, which flew more than 148 hours during six HS3 science flights.

Operation IceBridge

Researchers with NASA's



NASA/Michael Studinger

NASA's DC-8 monitors sea ice conditions over the Weddell Sea as the CryoSat-2 Satellite passes the same area on Nov. 7, 2012. By flying the DC-8 and the satellite over the same area at the same time, NASA scientists can calibrate the instruments onboard the satellite.

Operation IceBridge completed a five-week Antarctic field campaign this fall aboard the agency's DC-8 airborne science laboratory from Punta Arenas, Chile. From Oct. 12 to Nov. 8, researchers gathered valuable information on land and sea ice during 16 science missions over Antarctica. During this year's fourth Antarctic campaign, IceBridge scientists added to existing sea ice elevation data, surveyed new areas of the Antarctic ice sheet and reached out to students, teachers and the public.

ER-2 Missions

NASA's high-altitude ER-2 aircraft flew a number of missions this year, including deployments to

Iceland and the agency's Wallops Flight Facility for research using a new laser altimeter dubbed MABEL. The Multiple Altimeter Beam Experiment Lidar was developed at NASA's Goddard Space Flight Center to simulate a similar instrument planned for NASA's IceSat-2 satellite that is scheduled for launch in 2016.

UAVSAR

The Uninhabited Aerial Vehicle Synthetic Aperture Radar, or UAVSAR, flies aboard NASA's C-20A aircraft. Missions in 2012 included glacier research of Iceland's ice caps; volcano studies in Hawaii, Alaska, Japan and in the Cascade Range in Oregon and Washington; landslide imaging

in Colorado; soil moisture studies in the U.S. Midwestern states, and flights over earthquake faults in the Southwest.

SOFIA Observatory

NASA's Stratospheric Observatory for Infrared Astronomy began checkout and validation flights in early December after undergoing major upgrades to its mission command and control system and avionics systems during most of the year. The flying observatory is slated to begin its Cycle 1 series of astronomical observations with its first-generation instruments in spring 2013.

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Spaceflight Technology Flight Opportunities Program

NASA's Flight Opportunities Program sponsored the first successful free flight of a new control system for Masten Space Systems' Xombie suborbital vertical landing demonstrator on Feb. 2 at the Mojave Air and Space Port, Mojave, Calif. The flight used a new flight control system concept that will enable future demonstrations of landing technologies needed for exploration of planets and moons, as well as near-Earth objects, like asteroids.

The Flight Opportunities program's mission is to oversee the integration and flight of a variety of technology payloads on commercial suborbital reusable vehicles near the boundary of space to help meet the agency's research and technology needs.



Photo courtesy of Draper Laboratory

Masten Space Systems' Xombie rocket with Draper Laboratory's GENIE flight control system had its first untethered flight from the Mojave Air and Space Port.

Space Shuttle Endeavour's Final Journey

The highlight of the year for the public and for many Dryden staffers as well was the stopover of space shuttle Endeavour and its modified NASA 747 Shuttle Carrier Aircraft Sept. 20 during the final ferry flight of a shuttle from the Kennedy Space Center to Los Angeles, where it was turned over to the California Science Center for museum exhibit.

Following an overnight stay at Dryden, the SCA and Endeavour saluted the communities of Palmdale, Lancaster, Rosamond and Mojave with low-level flyovers before heading north to Sacramento and the San Francisco Bay Area on its Tour of California. More than two million people were estimated to have watched the SCA-Endeavour combo during low-altitude flyovers of famed landmarks in both Northern and Southern California, with extensive media coverage giving millions more the opportunity



ED12 317-066

NASA/Tom Tschida photo

Californians gazed at the morning sky Sept. 21 in an attempt to see the Endeavour and NASA 747 Shuttle Carrier Aircraft fly over their community.

to watch the flyovers and the subsequent overland journey through Los Angeles to the science center museum three weeks later.

Dryden supported the science center's grand opening of the Endeavour exhibit on Oct. 30 and the related six-day SpaceFest.

NASA had more than three dozen exhibits, displays, and educational demonstrations honoring aeronautics and space exploration.

ER-2 is back in the sky

By **Beth Hagenauer**
Dryden Public Affairs

NASA's high-altitude ER-2 No. 806 completed a functional check flight Dec. 12 that validated the aircraft's systems. The ER-2 recently concluded five months of maintenance work that included a 600-hour airframe inspection and 800-hour engine inspection.

A new addition to the aircraft is the NASA Airborne Science Data and Telemetry System that records navigation data and controls uplink and downlink capabilities through Iridium satellites.

An upgraded Experiment Interface Panel has a new Ethernet capability that enables more data



ED12-0393-08

NASA/Tom Tschida

ER-2 No. 806 is back in service.

transmission and command and control options for science payloads.

The aircraft will prepare for January 2013 flights of the NASA Goddard Space Flight Center's ER-2 X-band Radar, or EXRAD, mission. This study will be followed in February with Earth remote sensing research using the NASA Jet Propulsion Laboratory's Airborne

Visible Infrared Imaging Spectrometer, or AVIRIS.

AVIRIS and the MODIS/ASTER Airborne Simulator (MASTER) sensors, the latter co-developed by JPL and NASA's Ames Research Center, will be installed in 806 to study Earth's ecosystems during flights planned for mid-March through mid-April. This is a preparatory airborne study supporting the development of the NASA decadal survey Hyper-spectral Infrared Imager (HyspIRI) satellite mission.

The ER-2, with the capability of flying to 70,000 feet, will also carry the Large Area Collectors used to collect cosmic dust samples that provide valuable information about the origin and history of the solar system. These flights are planned for late April.

Turning trash into treasure

By **Jay Levine**
X-Press editor

More than a ton of electronic waste was collected for recycling during a drive organized from Dec. 3-19.

Jennifer Gocke, a key organizer, said employees from Dryden's main campus on Edwards and the Dryden Aircraft Operations Facility in Palmdale were invited to participate.

The Dryden Sustainability Team sponsored the event in partnership with the Dryden Environmental Office and the City of Lancaster. Lancaster representatives came to Dryden to collect the 2,100 pounds of materials and take them for proper disposal at no cost to Dryden.

The America Recycles Day in November provided ideas to the Sustainability Team to conduct this event, Gocke said.

"It was very successful and I will recommend to the team that we do this at least once a year," she said.

Many employees told Gocke they were just happy to clean out their garages.



ED12-0393-08

NASA/Tom Tschida

Dale McCoy of Dryden's Environmental Office helps load up items for recycling from Dryden's electronic waste collection.

Lancaster, in conjunction with CalRecycle, operates the Lancaster Recycling Center at the City of Lancaster Maintenance Yard at 615 W. Ave. H. That is where the Dryden electronic waste was taken.

The items could be recycled and used for a range of products, which include the design and manufacturing of Olympic medals, faucets, garden furniture and auto parts.

Research published

Dryden research contributions are detailed in recently released technical publications.

Monica Hoffman, Earl Allen, John Yount, and April Norcross collaborated on, "Positional Awareness Map 3D (PAM3D)," ITC-12-10-02. It was presented at the International Telemetry Conference, San Diego, Calif., Oct. 25-28, 2012.

William L. Ko and Van Tran Fleischer co-authored, "Improved Displacement Transfer Functions for Structure Deformed Shape Predictions Using Discretely Distributed Surface Strains," NASA/TP-2012-216060.

Dryden technical publications are available at the Dryden Research Library. Items that are restricted in distribution, such as International Traffic in Arms Regulations, or ITAR, are available in paper form at the research library.

Fuel savings

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aircraft in the future.

For another experiment planned to fly next summer on the FAST F/A-18, a "thin film" sensor manufactured by TAO Systems Inc., is currently being applied to one of the aircraft's wing surfaces. This technology will allow real-time characterization of the airflow over the wing. This sensor capability could lead to considerable weight reduction, fuel savings, and flight safety enhancement in future aircraft designs by revealing the actual flight loads on an aircraft to help ensure that design loads are not exceeded.

Another use for this technology could be to reduce the effects of gusts and turbulence on an aircraft when coupled with appropriate flight control algorithms.

Ikhana capabilities to be expanded

By **Beth Hagenauer**

Dryden Public Affairs and

Kimberly Kasitz

General Atomics Aeronautical Systems, Inc.

Dryden and General Atomics Aeronautical Systems, Inc., or GA-ASI, have partnered in a collaborative agreement to allow for the development and flight testing of new command and control satellite link capabilities on a Predator B unmanned aircraft system.

As the result of a no-cost Space Act Agreement signed in September, the parties will upgrade the command and control system of NASA's MQ-9 Predator B, named "Ikhana," to enable aircraft operations in more remote geographical regions. The upgraded aircraft will then be used to conduct systems testing and evaluation flights. This activity will allow both NASA and GA-ASI to reach the mutual goal of demonstrating this advanced capability.

"The system improvements enabled by this agreement expand the utility of the Ikhana MQ-9 for NASA science and the development of technology required for unmanned air systems to fly in the national airspace," said Dryden Center Director David McBride. "Both are key national priorities that benefit from this government/industry cooperative effort."

"We are pleased to renew our commitment to NASA and to help expand the utility of Ikhana to

Arctic missions," said Frank Pace, president of the Aircraft Systems Group, GA-ASI. "With growing interest in using remotely piloted aircraft for civil missions, we expect our work with NASA to open the door for increased confidence in operating these aircraft in the National Airspace System."

"This new capability will allow Ikhana to support NASA science missions at higher latitudes where many important geophysical processes must be studied," said Bob Curry, Dryden chief scientist. "In recent years, unmanned aircraft have demonstrated transformational opportunities for Earth science airborne research, particularly due to their very long endurance capability. They can also reduce the need to expose aircrew to remote and unforgiving environments."

NASA is using the aircraft in advanced flight research activities including those paving the way for opening up the National Airspace System to unmanned aircraft systems operation, in addition to its role in advancing science.

The next mission for NASA's Predator B aircraft, planned for the summer of 2013, is the Marginal Ice Zone Observations and Processes Experiment, or MIZOPEX. NASA will provide the aircraft system and its associated engineering, technical and operational staff to support Ikhana's mission to carry science instruments designed to



Photo courtesy of GA-ASI

Dryden center director David McBride and Frank Pace, president of General Atomics Aeronautical Systems' Aircraft Systems Group, stand by the Ikhana during McBride's recent visit to the firm's Poway, Calif., facility.

investigate ice changes in the Arctic. The MIZOPEX team is comprised of scientists led by James Maslanik of the University of Colorado at Boulder. The science project manager is John Adler of the National Oceanic and Atmospheric Administration.

Ikhana was manufactured by GA-ASI and delivered to NASA in 2006. Ikhana carried the NASA-developed Autonomous Modular Scanner for the multi-year Western States Fire Mission in 2007 and 2008 that investigated fires in the Western United States, especially

California. Working closely with the Federal Aviation Administration, the remotely piloted aircraft flew in the National Airspace System allowing the sensor to deliver near-real time wildfire information to incident commanders in the field.

Ikhana is capable of reaching altitudes above 40,000 feet and flying for more than 20 hours. The aircraft recently underwent a major retrofit that included integrating redundant avionics, wingtip antennas, laser altimeters, centerline hard points and greater electrical power generation capability.

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